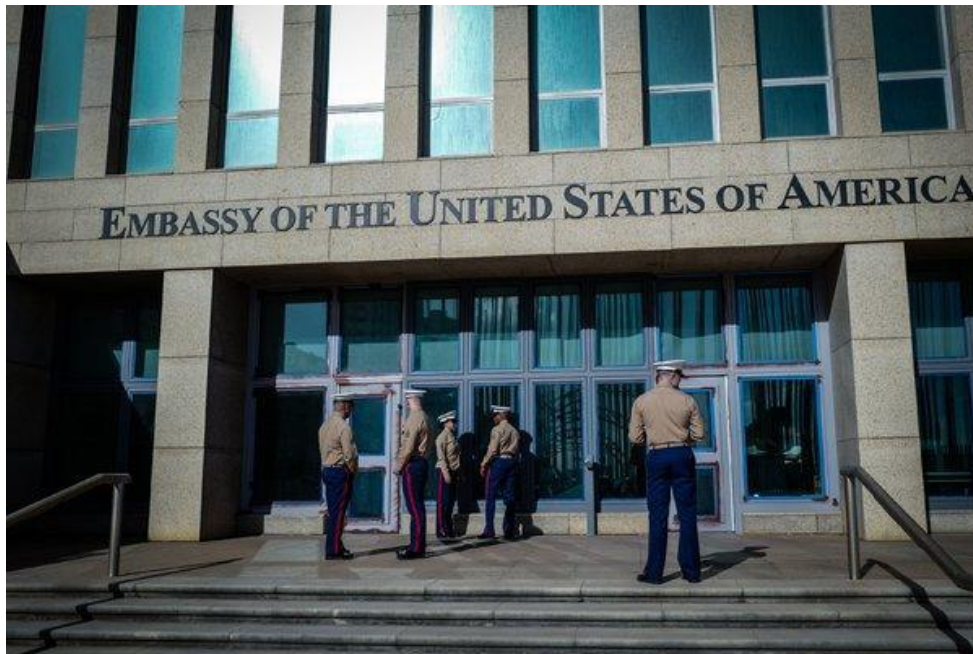


# Microwave Weapons Are Prime Suspect in Ills of U.S. Embassy Workers

Doctors and scientists say microwave strikes may have caused sonic delusions and very real brain damage among embassy staff and family members.



*U.S. Marines outside the embassy in Havana in February. Diplomats working here reported strange noises and mysterious symptoms that doctors and scientists say may have resulted from strikes with microwave weapons.*

*Credit Adalberto Roque/Agence France-Presse — Getty Images*

**By William J. Broad**

Sept. 1, 2018

During the Cold War, Washington feared that Moscow was [seeking to turn](#) microwave radiation into covert weapons of mind control.

More recently, the American military itself sought to develop microwave arms that could invisibly beam [painfully loud booms](#) and even [spoken words](#) into people's heads. The aims were to disable attackers and wage psychological warfare.

Now, doctors and scientists say such unconventional weapons may have caused the baffling symptoms and ailments that, starting in late 2016, hit more than three dozen American diplomats and family members in Cuba and China. The Cuban incidents resulted in a diplomatic rupture between Havana and Washington.

The medical team that examined 21 affected diplomats from Cuba made no mention of microwaves in [its detailed report](#) published in JAMA in March. But [Douglas H. Smith](#),

the study's lead author and director of the [Center for Brain Injury and Repair](#) at the University of Pennsylvania, said in a recent interview that microwaves were now considered a main suspect and that the team was increasingly sure the diplomats had suffered brain injury.

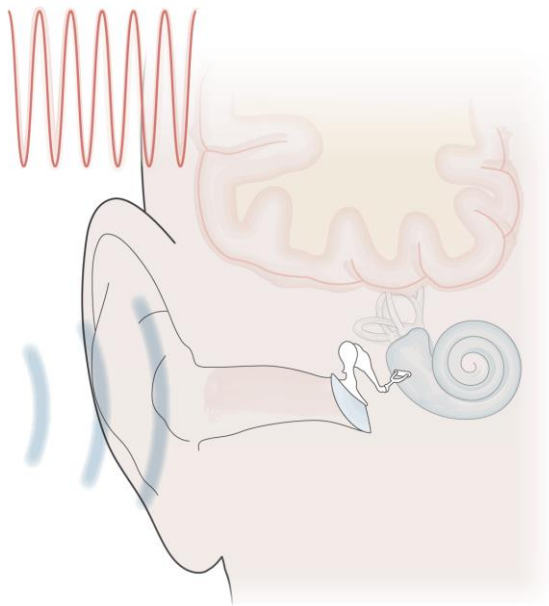
“Everybody was relatively skeptical at first,” he said, “and everyone now agrees there’s something there.” Dr. Smith remarked that the diplomats and doctors jokingly refer to the trauma as the immaculate concussion.

Strikes with microwaves, some experts now argue, more plausibly explain reports of painful sounds, ill and traumas than do other possible culprits — sonic attacks, viral infections and contagious anxiety.

In particular, a growing number of analysts cite an eerie phenomenon known as the [Frey effect](#), named after Allan H. Frey, an American scientist. Long ago, he found that microwaves can trick the brain into perceiving what seem to be ordinary sounds.

## Hearing Microwaves

Scientists have known for decades that the brain can perceive some microwaves as sound.



**SOUND WAVES** entering the ear make the eardrum vibrate. These vibrations are conveyed to the cochlea and converted into electrical signals. The brain's temporal lobes receive signals from the ears and process them into sounds and speech.

**MICROWAVES** hitting the head in the area around the temporal lobe were perceived as sound in a 1962 experiment. Several theories have sought to explain the exact mechanism but it remains in dispute.

*TEMPORAL  
LOBE*  
Cochlea  
Eardrum

*By The New York Times | Sources: Allan H. Frey;  
Centers for Disease Control and Prevention*

The false sensations, the experts say, may account for a defining symptom of the diplomatic incidents — the perception of loud noises, including ringing, buzzing and grinding. Initially, experts [cited those symptoms](#) as evidence of stealthy attacks with sonic weapons.

Members of Jason, [a secretive group](#) of elite scientists that helps the federal government assess new threats to national security, say it has been scrutinizing the diplomatic mystery this summer and weighing possible explanations, including microwaves.

Asked about the microwave theory of the case, the State Department said the investigation had yet to identify the cause or source of the attacks. And the F.B.I. declined to comment on the status of the investigation or any theories.

The microwave idea teems with unanswered questions. Who fired the beams? The Russian government? The Cuban government? A rogue Cuban faction sympathetic to Moscow? And, if so, where did the attackers get the unconventional arms?

At his home outside Washington, Mr. Frey, the scientist who uncovered the neural phenomenon, said federal investigators have questioned him on the diplomatic riddle and that microwave radiation is considered a possible cause.

Mr. Frey, now 83, has traveled widely and long served as a contractor and a consultant to a number of federal agencies. He speculated that Cubans aligned with Russia, the nation's longtime ally, might have launched microwave strikes in attempts to undermine developing ties between Cuba and the United States.

"It's a possibility," he said at his kitchen table. "In dictatorships, you often have factions that think nothing of going against the general policy if it suits their needs. I think that's a perfectly viable explanation."



*Allan H. Frey, at his home outside Washington. In 1960, he stumbled on an acoustic effect of microwaves that was eventually named after him.*

*Credit Alex Wroblewski for The New York Times*

## Developing a new class of weapons

Microwaves are ubiquitous in modern life. The short radio waves power radars, cook foods, relay messages and link cellphones to antenna towers. They're a form of electromagnetic radiation on [the same spectrum](#) as light and X-rays, only at the opposite end.

While radio broadcasting can employ waves a mile or more in length, microwaves range in size from roughly a foot to a tiny fraction of an inch. They're seen as harmless in such everyday uses as microwaving foods. But their diminutive size also enables tight focusing, as when dish antennas turn disorganized rays into concentrated beams.

The dimensions of the human head, [scientists say](#), make it a fairly good antenna for picking up microwave signals.

Mr. Frey, a biologist, said he stumbled on the acoustic effect in 1960 while working for General Electric's Advanced Electronics Center at Cornell University. A man who measured radar signals at a nearby G.E. facility came up to him at a meeting and confided that he could hear the beam's pulses — *zip, zip, zip*.

Intrigued, Mr. Frey traveled to the man's workplace in Syracuse and positioned himself in a radar beam. "Lo," he recalled, "I could hear it, too."

Mr. Frey's resulting papers — reporting that even deaf people could hear the false sounds — founded a new field of study on radiation's neural impacts. Mr. Frey's [first paper](#), in 1961, reported that power densities 160 times lower than "the standard maximum safe level for continuous exposure" could induce the sonic delusions.

His [second paper](#), in 1962, pinpointed the brain's receptor site as the temporal lobes, which extend beneath the temples. Each lobe bears a small region — the auditory cortex — that processes nerve signals from the outer and inner ears.

Investigators raced to confirm and extend Mr. Frey's findings. At first they named the phenomenon after him, but eventually called it the [microwave auditory effect](#) and, in time, more generally, [radio-frequency hearing](#).

The Soviets took notice. Not long after his initial discoveries, Mr. Frey said, he was invited by the Soviet Academy of Sciences to visit and lecture. Toward the end, in a surprise, he was taken outside Moscow to a military base surrounded by armed guards and barbed-wire fences.

"They had me visiting the various labs and discussing the problems," including the neural impacts of microwaves, Mr. Frey recalled. "I got an inside look at their classified program."

Moscow was so intrigued by the prospect of mind control that it adopted [a special terminology](#) for the overall class of envisioned arms, calling them psychophysical and psychotronic.

Soviet research on microwaves for "internal sound perception," the [Defense Intelligence Agency warned](#) in 1976, showed great promise for "disrupting the behavior patterns of military or diplomatic personnel."

Furtively, globally, the threat grew.



The National Security Agency gave [Mark S. Zaid](#), a Washington lawyer who routinely gets security clearances to discuss classified matters, [a statement](#) on how a foreign power built a weapon “designed to bathe a target’s living quarters in microwaves, causing numerous physical effects, including a damaged nervous system.”

Mr. Zaid said a N.S.A. [client of his](#) who traveled there watched in disbelief as his nervous system later unraveled, starting with control of his fingers.



*The high-pitched chirping that diplomats heard while working at the Consulate General of the United States in Guangzhou, China, might be explained by a phenomenon known as the Frey effect — radio-frequency hearing.*

*Credit Lam Yik Fei for The New York Times*

Washington, too, foresaw new kinds of arms.

In Albuquerque, N.M., Air Force scientists sought to beam comprehensible speech into the heads of adversaries. Their novel approach won a patent [in 2002](#), and an update [in 2003](#). Both were assigned to the Air Force secretary, helping limit the idea’s dissemination.

The lead inventor [said the research team](#) had “experimentally demonstrated” that the “signal is intelligible.” As for the invention’s uses, an Air Force [disclosure form](#) listed the first application as “Psychological Warfare.”

The Navy sought to paralyze. The Frey effect was to induce sounds powerful enough [to cause painful discomfort](#) and, if needed, leave targets [unable to move](#). The weapon, [the Navy noted](#), would have a “low probability of fatalities or permanent injuries.”

In a twist, the 2003 contract was awarded to microwave experts [who had emigrated](#) to the United States from Russia and Ukraine.

It is unknown if Washington deploys such arms. But the Pentagon built a related weapon known as the Active Denial System, hailing it [in a video](#). It fires an invisible beam [meant to deter](#) mobs and attackers with fiery sensations.

Russia, China and many European states are seen as having the know-how to make basic microwave weapons that can debilitate, sow noise or even kill. Advanced powers, experts say, might accomplish more nuanced aims such as beaming spoken words into people's heads. Only intelligence agencies know which nations actually possess and use such unfamiliar arms.

The basic weapon might look like a satellite dish. In theory, such a device might be hand-held or mounted in a van, car, boat or helicopter. Microwave arms are seen as typically working over relatively short distances — across the length of a few rooms or blocks. High-powered ones might be able to fire beams across several football fields, or even for several miles.

## The episode in Cuba

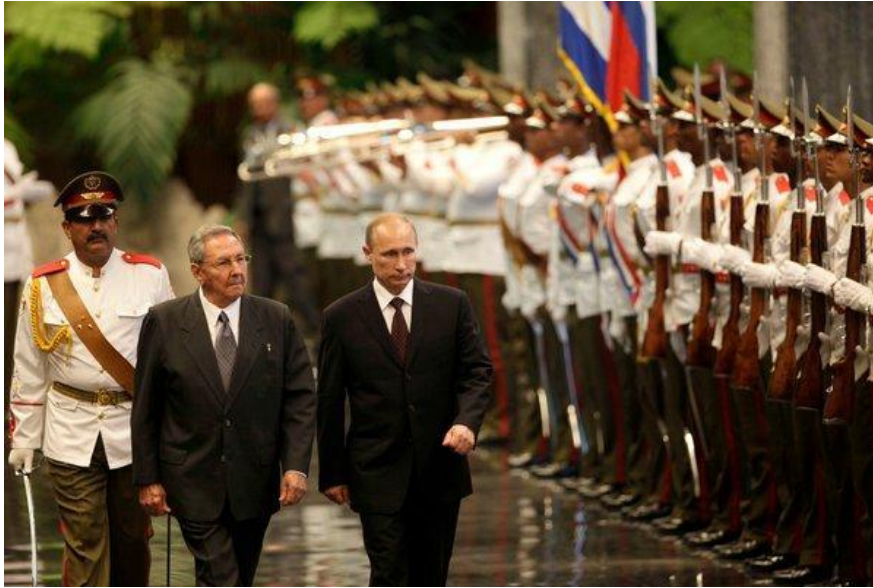
The Soviet collapse in 1991 cut Russia's main ties to Cuba, a longtime ally just 90 miles from the United States. The shaky economy forced Moscow to stop providing Havana with large amounts of oil and other aid.

Vladimir Putin, as Russia's president and prime minister, [sought to recover](#) the economic, political and strategic clout that the Soviets had lost. In December 2000, months after the start of his first presidential term, [Mr. Putin flew to the island nation](#). It was the first visit by a Soviet or Russian leader since the Cold War.

He also sought to resurrect Soviet work on psychoactive arms. In 2012, [he declared](#) that Russia would pursue “new instruments for achieving political and strategic goals,” including psychophysical weapons.

In July 2014, Mr. Putin again visited Cuba. This time he brought a gift — the cancellation of [some \\$30 billion](#) in Cuban debt. The two nations signed a dozen accords.

A Russian spy ship, Viktor Leonov, [docked in Havana](#) on the eve of the beginning of reconciliation talks between Cuba and the United States in early 2015, and [did so again](#) in subsequent years. Moscow and Havana grew so close that in late 2016, the two nations signed [a sweeping pact](#) on defense and technology cooperation.



*Raul Castro, president of Cuba, with Vladimir Putin, Russia's president, at a welcoming ceremony for Mr. Putin in Havana in 2014.*

*Credit Ismael Francisco/Associated Press*



*In Havana's harbor, men fishing near the Russian warship, Viktor, Leonov, in 2015.*

*Credit Ramon Espinosa/Associated Press*

As a candidate, Donald Trump faulted the Obama administration's [normalization policy](#) as “a very weak agreement” and threatened to scrap it on reaching the White House. Weeks after he won the election, [in late November 2016](#), the American embassy in Havana found itself battling a mysterious crisis.

Diplomats and their families [recounted high-pitched sounds](#) in homes and hotel rooms at times intense enough to incapacitate. Long-term, the symptoms included nausea, crushing headaches, fatigue, dizziness, sleep problems and hearing loss.



The State Department filed diplomatic protests, and the Cuban government denied involvement. In May, the F.B.I. opened an investigation and its agents began visiting Havana a half year after the incidents began. The last major one hit that summer, [in August](#), giving the agents relatively little time to gather clues.

Video [Active Denial System](#)

In 2016, diplomats at the United States Embassy in Havana were mysteriously stricken. Was it an attack? There is no official explanation, but the episode has played a big role in America's current political disengagement with Cuba. Published On April 18, 2018

In September 2017, the Trump administration warned travelers away from Cuba and [ordered home](#) roughly half the diplomatic personnel.

Rex W. Tillerson, who was then the secretary of state, said the embassy's staff had been targeted deliberately. But he refrained from blaming Cuba, and federal officials held out the possibility that a third party may have been responsible.

In early October, [President Trump expelled](#) 15 Cuban diplomats, producing a chill between the nations. Administration critics said the White House was using the health issue [as a pretext](#) to end President Barack Obama's reconciliation policy.

The day after the expulsions, the Senate Foreign Relations Committee held a closed, [top secret hearing](#) on the Cuba situation. Three State Department officials testified, as did an unnamed senior official of the Central Intelligence Agency.

## The Hypothesis



*Beatrice A. Golomb, a medical doctor and professor of medicine at the University of California, San Diego, here in a beachside office, argues that microwave strikes can explain the diplomatic ill.*

*Credit Tara Pixley for The New York Times*



Early this year, in January, the spooky impact of microwaves on the human brain never came up during an open [Senate hearing](#) on the Cuba crisis.

But in a scientific paper that same month, [James C. Lin](#) of the University of Illinois, a leading investigator of the Frey effect, [described the diplomatic ill](#)s as plausibly arising from microwave beams. Dr. Lin is the editor-in-chief of Bio Electro Magnetics, [a peer-reviewed journal](#) that explores the effects of radio waves and electromagnetic fields on living things.

In his paper, he said high-intensity beams of microwaves could have caused the diplomats to experience not just loud noises but nausea, headaches and vertigo, as well as possible brain-tissue injury. The beams, he added, could be fired covertly, hitting “only the intended target.”

In February, ProPublica [in a lengthy investigation](#) mentioned that federal investigators were weighing the microwave theory. Separately, it told of an intriguing find. The wife of a member of the embassy staff, it reported, had looked outside her home after hearing the disturbing sounds and seen a van speeding away.

A dish antenna could fit easily into a small van.

The medical team that studied the Cuba diplomats ascribed the symptoms in [the March JAMA study](#) to “an unknown energy source” that was highly directional. Some personnel, it noted, had covered their ears and heads but experienced no sound reduction. The [team said](#) the diplomats appeared to have developed signs of concussion without having received any blows to the head.

In May, [reports emerged](#) that American diplomats in China had suffered similar traumas. Secretary of State Mike Pompeo [called the medical details](#) of the two groups “very similar” and “entirely consistent” with one another. By late June, the State Department had evacuated [at least 11 Americans](#) from China.

To date, the most detailed medical case for microwave strikes has been made by [Beatrice A. Golomb](#), a medical doctor and professor of medicine at the University of California, San Diego. In a forthcoming paper to be published in October in [Neural Computation](#), a peer-reviewed journal of the MIT Press, she lays out potential medical evidence for Cuban microwave strikes.

She compared the symptoms of the diplomats in Cuba to those reported for individuals said to be suffering from radio-frequency sickness. The health responses of the two groups, [Dr. Golomb wrote](#), “conform closely.”

In closing, she argued that “numerous highly specific features” of the diplomatic incidents “fit the hypothesis” of a microwave attack, including the Frey-type production of disturbing sounds.

Scientists still disagree over what hit the diplomats. Last month, JAMA [ran four letters](#) critical of the March study, some faulting the report for ruling out mass hysteria.

But Mr. Zaid, the Washington lawyer, who represents eight of the diplomats and family members, said microwave attacks may have injured his clients.

“It’s sort of naïve to think this just started now,” he said. Globally, he added, covert strikes with the potent beams appear to have been going on for decades.

Francisco Palmieri, a State Department official, was asked during the [open Senate hearing](#) if “attacks against U.S. personnel in Cuba” had been raised with Moscow.

“That is a very good question,” Mr. Palmieri replied. But addressing it, he added, would require “a classified setting.”

For his part, Mr. Frey says he doubts the case will be solved anytime soon. The novelty of the crisis, its sporadic nature and the foreign setting made it hard for federal investigators to gather clues and draw conclusions, he said, much less file charges.

“Based on what I know,” he remarked, “it will remain a mystery.”

William J. Broad is a science journalist and senior writer. He joined The Times in 1983, and has shared two Pulitzer Prizes with his colleagues, as well as an Emmy Award and a DuPont Award. [@WilliamJBroad](#)

A version of this article appears in print on Sept. 1, 2018, on Page A1 of the New York edition with the headline: Invisible Strike May Be Cause Of Envoys’ Ills. [Order Reprints](#) | [Today’s Paper](#) | [Subscribe](#)

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